ENERGY AUDIT STUDY

at

WELCAST STEELS LIMITED
BANGALORE

UNDER
INDIA-EC ENERGY BUS PROGRAMME

Sponsored by

ENERGY MANAGEMENT CENTRE
(Under Deptt. of Power, Ministry of Energy, Govt. of India)
New Delhi

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WELCAST STEELS LTD
BANGALORE

ENERGY AUDIT REPORT

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EXECUTIVE SUMMARY

Energy audit study was conducted at Welcast Steels Ltd., Bangalore by a team of engineers from TATA Energy Research Institute, Bangalore on the request of the management of the plant.

The study team visited the plant on January 11th, 12th, 13th and 15th, 1991. The Instruments available with TERI,s energy bus were utilised in measuring various parameters in the plant. After analysing the data provided by the plant personnel and the measurements made the following observations and recmmendations were arrived.

SUMMARY OF OBSERVATIONS & RECOMMENDATIONS

	RECOMMENDATION	SAVINGS/ANNUM UNITS	RUPEES
1.	Relining the 250 kW Induction furnace refractory & reduce cooling water losses	45600	52000
2.	Covering the top portion of both induction furnaces after the metal has melted.	10800	12000
3.	Improving the insulation of RF1 & RF2	21000	24500
4.	Closing the RF door during loading & unloading the charge from the trolly.	Not Quantified	
5.	Substituting LDO instead of HSD for ladle preheating	-	40000

6.	Reducing the gap between ladle and wall while preheating	Not Quantified	
7.	Extending air intake portion of compressor	4500	6500
8.	Plugging all the compressed air leakages	Not Quantified	
9.	Replacing 500 W incandescent with HPSV	12000	13500
10.	Providing transparant sheets in the roof for better day light	Not Quantified	
11.	Transformer Load Management	10356	20712
12.	Changing of tap position of transformers	3286	6572
13.	Reduction of Contract Demand to 2000 KVA	-	330000

WELCAST STEELS LTD

ENERGY AUDIT REPORT

1.0 INTRODUCTION:

Welcast Steels Ltd., is a steel foundry, produceing saleable grinding media in the form of balls and castings in the scrap-induction furnace route. The foundry unit consists of 2 Induction furnaces and 5 resistance furnaces with an average total production of 3240 tons of saleable grinding media per annum.

2.0 PROCESS DESCRIPTION:

The iron scrap from the yard is melted in the Induction furances and the molten metal at 1500 °C is taken to the casting zone with the help of a ladle. The cast ingots and balls are then cooled and transferred to hardening furnaces. The hot material from the hardening furnaces at 1000°C is fed to the quenching tray and is allowed to cool down to the room temperature with the help of blowers blowing air from the bottom. After this the quenched material is fed to the tempering furnace with the help of a bucket, which is kept inside the furnace along with the material. Finally the material goes through the routine inspection, quality control and packing & despatch.

TABLE 1

ENERGY CONSUMPTION PATTERN Jan-Oct 1990

MONTHS	KEB kWh	GEN.ELEC kWh	TOTAL kWh
Jan	539400	17000	556400
Feb	608100	10800	618900
Mar	532200	17000	549200
Apr	566700	12000	578700
May	569400	24800	594200
Jun	604200	22000	626200
Jul	652200	16000	668200
Aug	623700	15400	639100
Sep	576000	9600	585600
Oct	654600	5940	660540

	COST(Rs.)
PUR.ELECTRICITY	9545790
DIESEL	215100

3.0 ENERGY CONSUMPTION PATTERN:

Electricity is the main energy input to the plant with purchased electricity accounting to almost 98 % of the energy bill and diesel for self generation forming only 2% (Table 1.) The plant has a maximum demand of 3000 kVA and the annual energy bill is around Rs. 98 lacs.

The monthly variation of energy consumption along with self generation for the year 1990 is shown in figure 1.

The main energy consuming equipment in the plant are:

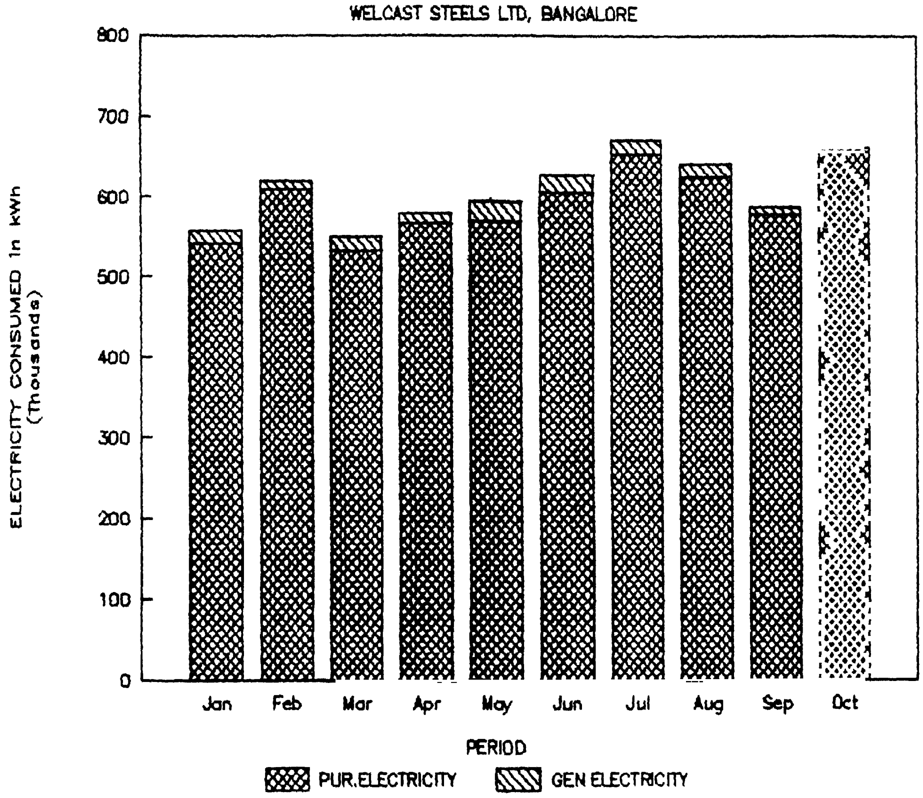
1) Induction furnaces (750 kW & 250 kW)
2) Heat treatment furnaces (2 Nos of 160 kW, one 95 kW & two 45 kW)
3) Ladle preheating system
4) Compressed air system

With this in view the study has been mainly concentrated on these equipments, which are discussed in the subsequent chapters.

FIG. 1.

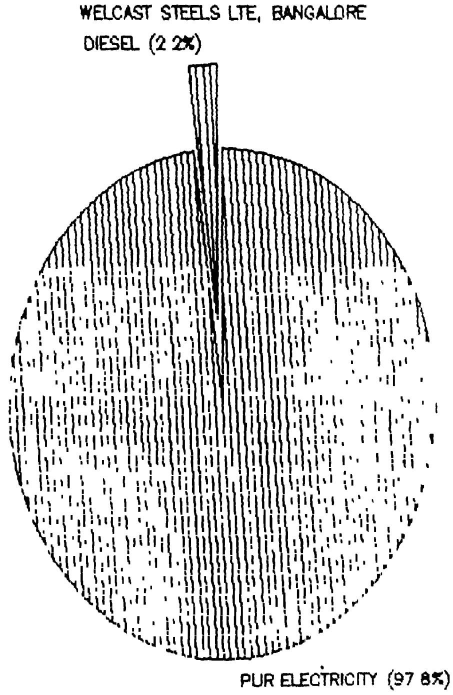
MONTHLY ENERGY CONSUMPTION 1990

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SOURCE WISE ENERGY CONSUMPTION

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INDUCTION FURNACES

750 kW:

This is a 1 ton capacity furnace which is operated for almost 24 hours. The volumetric capacity of the furnace is 1.05 LMT (Liquid Metal Ton). The furnace has water cooled power cables and the heating cycle consists of 3 stages.

The furnace is operated with 300 kW during the first 7 minutes , with 750 kW for the next 48 minutes and in the third stage only 100 kW is given for the next 20-25 minutes to maintain the molten metal temperature. The rate and time of heating is also varied according to the density of the scrap available. The scrap with a density greater than 3.5 requires one hour of operation where as the local scrap with a density of less than 1 takes 70-75 minutes.

Initially 180 kg of molten metal is discharged for about 2 minutes while the entire operation of discharging takes place for about 12-15 minutes.

The desired temperature variation of molten metal is 1370 - 1390 ^{o}C for cromium cast iron balls of 2 to 3 % carbon and 1500 ^{o}C for SG iron castings. A superheat of 30 - 50 ^{o}C is generally given to compensate for the channel losses.

250 kW:

The volumetric capacity of this furnace is 550 kg of liquid metal. The melting time of this furnace is around 1 hour 45 minutes. The other parameters are all similar to the 750 kW furnace.

TABLE 2

ENERGY BALANCE OF 750 KW FURNACE

ENERGY INPUT	K.CAL	%	ENERGY OUTPUT	K.CAL	%
Heat Supplied	602000	100	Heat utilised (heat in steel)	228330	37.9
			Heat in slag	8148	1.4
			Heat loss through cooling water	249600	41.5
			Radiation & other surface losses	57190	9.5
			Un-accounted loss	58732	9.7
TOTAL	602000	100		602000	100

TABLE 3

ENERGY BALANCE OF 250 KW FURNACE

ENERGY INPUT	K.CAL	%	ENERGY OUT PUT	K.CAL	%
Heat supplied	331100	100	Heat utilised (Heat in steel)	114160	34.5
			Heat in slag	4365	1.3
			Heat loos through cooling water	196800	59.4
			Radiation and other loss	15775	4.5
TOTAL	331100	100		331100	100

OBSERVATIONS & RECOMMENDATIONS:

The energy balance of 750 kW furnace and 250 kW furnace is given in table 2 & 3 respectively. Pie charts are shown (fig 2 & 3) indicating the thermal energy utilisation of both the furnaces.

It can be seen from the figures that the efficiency of 750 kW furnace is around 37.9 % and that of 250 kW furnace is 34.5 %. The heat given to the cooling water in the bigger furnace is around 41.5 % where as in the smaller furnace it is around 59.4 %, which seems to be on the higher side.

The high cooling water loss indicate that the refractory lining is in a bad state. It is recommended to check the lining of the refractory and reline it so that the cooling water loss is brought down.By reducing the loss through cooling water the efficiency of the furnace can be increased by another 5 % resulting in the estimated savings of 45600 units of electricity amounting to Rs.52000 per annum.

It was observed during the study that after the metal has attained the molten form the top surface is still exposed to the atmosphere, where the hot gases were at a temperture of around 245 ^{o}C.

If the top area is covered with a refractory lined lid for atleast 30 minutes per melt it is possible to save around 10800 units of electricity resulting in monetory savings of about Rs.12000 per annum.

Fig. 2

ENERGY BALANCE – 750 KW FURNACE

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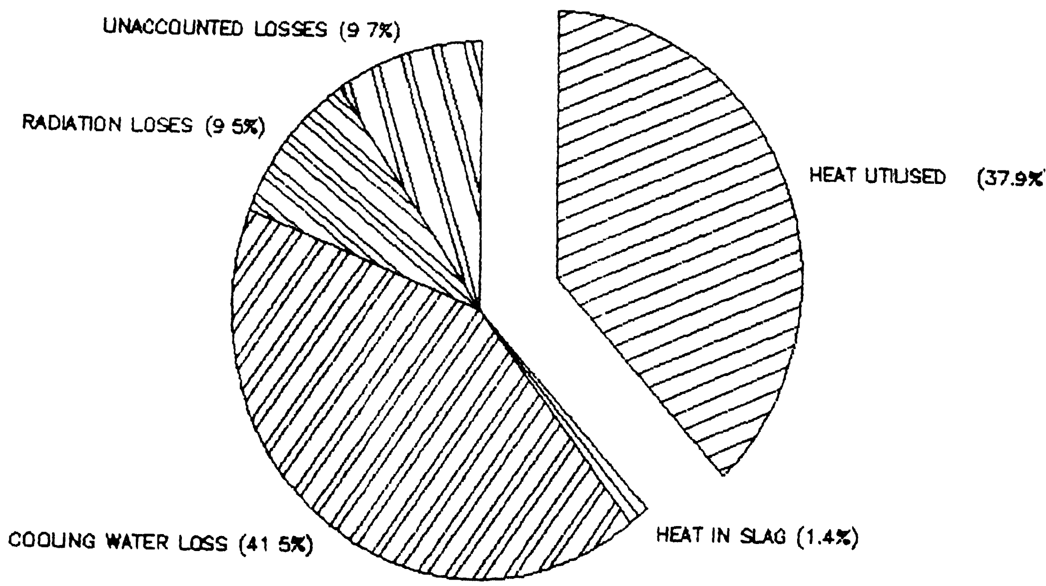
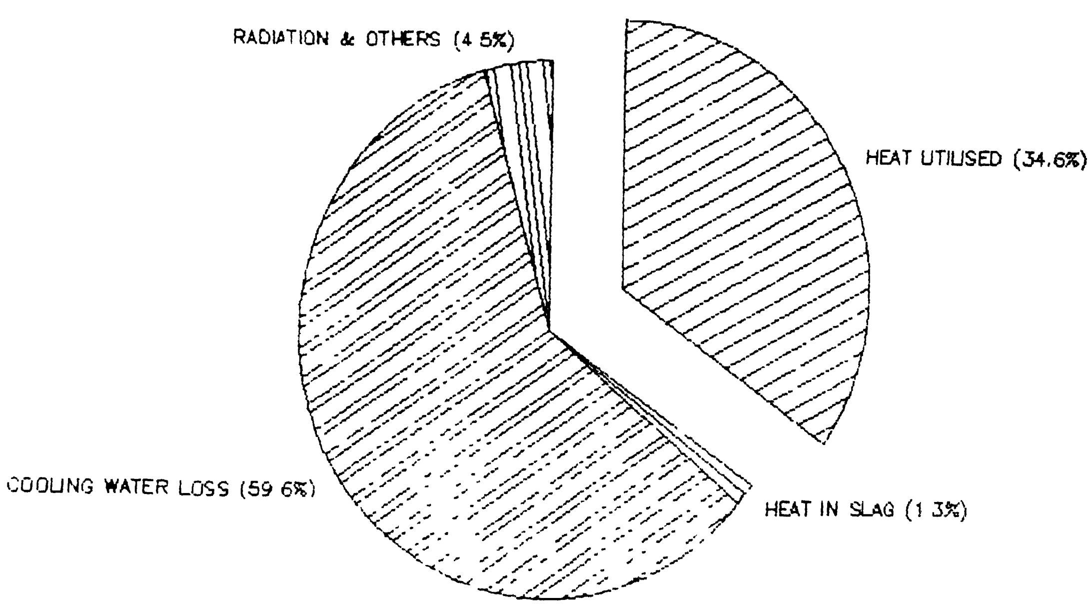


Fig. 3

ENERGY BALANCE – 250 KW FURNACE

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5.0 HEAT TREATMENT FURNACES

There are two furnaces of 160 kW and one furnace of 90 kW for hardening purpose and 2 pit furnaces of 40 kW and 36 kW for the purpose of tempering.

The input material is in the round balls of different dia. The capacity of the 160 kW furnace is 1.2 tons. The material is heated to around 1000 °C in about 3 hours and is kept under soaking condition for nearly 7 hours with the help of thermostatic control.

OBSERVATIONS & RECOMMENDATIONS

The efficiency of the 160 kW resistance furnace was calculated to be 34.7 %. The bulk of heat was absorbed by the refrectory material inside the furnace. The exact quantity of loss was not calculated as the mass of the furnace was not available with the plant personnel. The radiation and convection losses were around 9.5 %.

The surface temperatures of RF 1 and RF 2 were found to be high at some zones. The average surface temperature at the door, left side, right side and roof were 88°C, 79°C, 73°C and 81°C respectively, with a maximum temperature of 111 °C on the left hand side from the door. The surface temperatures of RF 2 were still higher with a maximum temperature of around 170°C at the door.

The effective insulation of all these hot zones would result in the savings of around 21000 units of electricity amount to Rs.24500 per year.

It was observed during the study that during the period of unloading and recharging the furnace the door of the furnace is kept open even when the trolly is out of the furnace. It is recommended to close the door of the furnace as soon as the trolly comes out of the furnace thereby reducing the heat loss through the opening.

It is recommended to install seperate energy meters for all the big furnaces so that the energy monitoring will be perfect.

6.0 LADLE PREHEATING:

The ladle of capacity 180 kg is being preheated to 700 - 800 ^{o}C before it is taken for transferring molten metal from the induction furnaces to the moulds. Each ladle is being heated 42 times per day. The normal time required to preheat a ladle is around 10 minutes where as a newly lined takes 30 for getting preheated.

The fuel used to preheat the ladles is HSD, which is consumed at the rate of 80 litres per day. Ladle preheating is of horizontal type and the atomising media used is air from the blowers & compressed air.

OBSERVATIONS & RECOMMENDATIONS

The fuel used to preheat the ladle is HSD, which is a costly fuel. It is strongly recommended to substitute the fuel with LDO. Considering that the fuel consumption is around 80 lit/day the savings that would result by substituting LDO is around Rs.40000 per annum.

It was observed during the study that the gap between the wall and ladle is more(20 cm) and most of the flame is protruding out of the space. It is recommended to reduce the gap between the wall and the ladle to reduce heat loss.

Compressed air at 6 kg/cm^2 was found to be used as a combustion air for ladle preheating which is a costly process. It is recommended to use a blower instead of compressed air. Quantification was not possible as the compressed air details were not available.

7.0 COMPRESSED AIR SYSTEM:

There are two compressors of capacity 60 hp and 30 hp installed in the plant to supply the compressed air requirement for ramming tools, mixers, air hoists, moulding machines, pallet machines and other hand operated tools. The working pressure is around 110 psi.

CHESSEL RECORDER was installed on both the compressors to study the loading pattern. It was found that both the compressors are getting loaded and unloaded very frequently.

OBSERVATIONS & RECOMMENDATIONS

The room temperature in which the compressor is involved was around 5 ^{o}C more than the ambient. It is recommended to extend the intake portion of the compressor outside the room to get the relatively cold air. The savings achieved with this measure would be approximately Rs.6500 per year.

Compressed air leaks were found at many places in the plant. The controlling points at the hand tools were also found to be left open at some places. The exact quantum of losses could not be arrived at, as it was not possible to conduct the no load test to determine the amount of compressed air loss. However, it was estimated that the compressed air leaks would be around 35%.

Presently the receiver has a drain valve which is operated manually to remove the moisture in the receiver. Considerable amount of air is always lost with this process. It is recommended to go in for an air trap which removes moisture automatically without letting the commpressed air out.

8.0 LIGHTING:

The connected load of total lighting in the plant is 14.4 KWS. Out of this the active load is only 6.8 KWS. Mostly M.V. lamps are used for lighting purpose in the plant and S.V. lamps are used for security purpose.

The entire foundry area is lit with 500 W mercury lamps ,500 W incandescent lamps, and a few LPSV lamps of 400 W. There are other fluoroscent lamps installed in office rooms and other departments.

MEASUREMENTS & DATA COLLECTION

To determine the quality of existing lighting, illumination levels were measured at selected locations mainly in the foundry unit during the day time, using lux meter. Other factors which affect illumination, such as type of lamp used, type of luminaire, mounting height, use of day lighting etc., were also noted.

OBSERVATIONS & RECOMMENDATIONS

The illumination levels required in process industries as recommended by B.I.S is around 200 in casting areas, 300 lux in the finishing departments.

In general the illumination levels at some places in the foundry appear to be not sufficient. The illuminations levels measured during day time were less than 100 lux even when the mercury lamps were all burning.

It is recommended to replace all the 9 X 500 W incandescent lamps with 250 W HPSV lamps. It is estimated to save around 12000 units of electricity resulting in a saving of Rs. 13500 per annum apart from the consumption of HPSV lamps.

It was observed during the study that MV lamps were found installed in the foundry unit where there is no precision work involved. It is suggested to go in for HPSV lamps on a phased manner.

Transparant roof sheets provide better day light during the day time. It is suggested to replace some of the frames with transparant sheets to get better day light.

It was observed because of the dusty atmosphere of the factory many of the luminaires have been covered with dust. Even in a clean atmosphere such as an office dust reduces their light output by as much as 20 % and in foundries and some heavy engineering works the loss will be as high as 40 % or more. Additionally, the accumulation of dust on the upper surface of the luminaire can lead to overheating and consequent deterioration of wiring and control gear.

A regular cleaning schedule should be established and, although it should occur more frequently, and it can be times to coincide with the group replacement of lamps.

9.0 DIESEL GENERATING SET:

The energy audit team has studied various factors influencing the energy efficiency of the D G Set in the plant. Measurements of exhaust temperature and flue gas composition were made using portable oxygen analyser and draeger gas testing equipment.

There is one 500 kVA DG set loaded to the extent of 400 kW with an oil consumption rate of 90 lph.

The flue gas temperature was around 275 ^{o}C, the oxygen conten was of the order of 15 % and CO content was 600 ppm.

High oxygen content and CO were observed in the flue gas. It is recommended to refer this with the manufacturer and get the DG set properly tuned.

See Appendix I for operating tips on diesel and lube oil conservation in DG sets.

10.0 ELECTRICITY SUPPLY

The main source of Electricity is the K.E.B. Supply. The power supply is received at 11 KV and stepped down to 440 V. The Contract Demand is 3000 KVA. There are three nos. of distribution transformers viz., 2 x 500 KVA auxillary supply and the other 1 x 1000 KVA Furnace Transformer. Alternate source of supply is Diesel Generator set of capacity 500 KVA. The Diesel Generator is run during evening peak load hours when the load restrictions are imposed by K.E.B.

10.1 ELECTRICITY CONSUMPTION

The unrestricted Maximum Demand is 1710 KVA. The average consumption is of the order of 6.91 Mwhrs / per month. The average Electricity Bill per month works out to Rs. 9.75 lakhs. The overall power factor at the substation level is maintained at 0.97.

10.2 MEASUREMENTS & CALCULATIONS

Measurements of various electrical parameters were taken using Power Analyser, Energy Monitor etc.,

11.0 MAXIMUM DEMAND ANALYSIS

On an analysis of the measurements made it is observed that the plant load factor is of the order of 66.93%. The Diversity Factor based on the installed capacity of the transformers works out to 1.3. It is observed that though the Maximum Demand is less, the Billing Demand is high. This is because the Maximum Demand is less than the 75% of Contract Demand. Hence there is scope to reduce the Electricity Bill amount by

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ANALYSIS OF PERFORMANCE OF MOTORS

SLNO	--MOTOR REF-	--H.P.--	-HZ-	VOLTS-	AMPS	P.F.	-KVA-	-KWH	UNDER LOAD%	UNDER VOLT%	REMARKS
1	BLOWER 2	50.00	48.70	358.52	53.40	0.92	33.60	31.17	0.00	16	
2	MULLER	15.00	48.50	355.06	28.50	0.63	17.82	11.34	0.00	17	LOW P.F.
3	MIXER 3	15.00	48.70	4049.41	26.80	0.69	15.21	10.62	0.00	0	LOW P.F.
4	SOFNG.PLANT	12.50	48.70	386.23	9.60	0.74	6.42	4.80	48.49	10	LOW P.F.
5	COMP.MOT.I	60.00	48.70	386.23	70.60	0.77	47.10	36.42	0.00	10	LOW P.F.
6	COMP.MOT II	30.00	48.70	396.62	31.00	0.79	21.15	16.80	0.00	7	LOW P.F.

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reducing the Contract Demand. If the Contract Demand is reduced to 2000 KVA, it is estimated that there would be a sving of about Rs. 27,500/- month in Demand Charges. This works out to a saving of Rs.3,30,000 per year.

12.0 TRANSFORMER LOAD MANAGEMENT

The 1000 KVA Induction Furnace Transformer and 1 x 500 KVA auxillary transformer can be switched off during Weekly Holidays and General Holidays to miminise the iron losses during no load conditions. It is estimated that there would be a saving of about 10,356 Kwhrs/year. in iron losses.

13.0 ELECTRIC MOTORS

An analysis of six motors were carried out and the resulted are presented on the facing page. Analysis of Power Analyser measurements indicate that the Electric Motors are fairly loaded and are operating at satisfactory power factor levels.

The input voltage measured is of the order of 358 V. It is proposed to change the tap position of the 2 x 500 KVA transformer to the next lower level thereby improving the voltage by 2 1/2% ie., the transformer tap position has to be changed from no.3 normal position to no.4 with this arrangement it is estimated that there would be a saving of about 3,286 Kwhrs/year.

14.0 SUMMARY OF RECOMMENDATIONS (ELECTRICITY UTLISATION)

14.1 It is recommended to switch off 1 x 500 KVA auxillary transformer and 1 x 1000 KVA furnace transformer during Weekly Holidays and General Holidays to minimise the iron loses.

14.2 It is recommended that the tap position of the 2 x 500 KVA transformers be changed to next lower level to achieve an improvement of about 2 1/2% in the secondary voltage.

14.3 It is recommended to reduce the Contract Demand to 2000 KVA.

APPENDIX -I

Diesel Generator Sets

Operating Tips for Fuel and Lube Efficiency

1. Select proper fuel. If the injection system can tolerate more viscous fuels like LDO, furnace oil or other residual fuels like LSHS or HPS, go for higher viscosity fuels.

2. Ensure proper storage and handling of fuel. Dirt and contamination will make the fuel go off specification.

3. Load the DG set above 50 percent for large D.G.Sets, and above 60 percent for small sets.

4. Ensure proper fuel injection, correct viscosity and temperature, timing, proper mechanical condition of components, and prevent lube contamination.

5. Select proper lubricant. Monitor lubricant condition through regular sampling and analysis of used oil. Ensure proper lubricant cooling and consumption. (Thicker oil cause 2 percent excess fuel consumption).

6. Externally clean the air filters regularly, to ensure proper filteration and cleanliness of intake air.

7. Avoid leakges of fule oil and lube oil, even though they may be of minor nature. They are a major cause for higher fuel and lube consumption.

8. Norrally, engine oils of SAE 40 grades are used in D.G.sets, unless otherwise recommended by the manufacturers. Use of multigrade and higher performance level oils with high detergency, alkalinity reserve and antiwear properties help in both lube and fuel conservation i addition to improving engine mechanical efficiency.

9. Check compression pressure regularly if provision exists. Attend to stuck piston rings, leaky valves, clogged ports, excessive liner and ring wear, etc., promptly.

10. Insulate exhaust piping to reduce air temperature inside the generator room as the higher intake air temperature increases the specific fuel consumption and reduces engine output .(Engine output reduces by about 5 percent for 10°C rise in intake temperature).

11. Avoid exhaust gas temperature above 450°C.High exhaust temperatures due to overload and restricted air supply, could lead to lower fuel efficiency as well as fouling of turbo-chargers.

12. Avoid over lubrication to prevent deposits inside the engine and on the turbo-charger blades.

13. Maintain the cooling circuit system and clean heat exchangers regularly. Meet manufacturer's norms on cooling water temperature, back pressure, flow rate, quality, etc.,

14. Adopt preventive or preferably predictive maintenance programmes.

15. Attempt waste heat recovery, if technically and economically viable.

Measures for Diesel Engine Lubrication Oil Conservation

1. Improve air filtration.

2. Reduce fuel dilution by

   a. ensuring proper atomization
   b. having correct engine temperature
   c. having proper air-fuel ratio
   d. enuring proper crankcase venting
   e. eliminating worn out rings and cylinder liners

3. Check insolubles build-up in oil by using proper air, oil and fuel filters.

4. Reduce oil loss by proper clearance between valve stem and guide.

5. Reduce oil loss past piston by

   a. reducing carbon deposits on top land
   b. avoiding bore polishing and glazing
   c. attending to ring wear

6. Provide by-pass purification system or removeinsolubles by centrifuging.

7. Use long drain oils with improved air and oil filters

8. Monitor TBN values more closely where higher sulphur diesel is used.

9. Switch on to multigrade oils for oil as well as fuel economy.

10. Check for leaks in the lubrication svstem and attent to them promptly.

11. Change oil on condition basis and not on the thumb rule recommended by oil companies or engine builders. Field oil testing systems are readily available in the country.

12. Oil never deteriorates. It goes off specs temporarily. The drained oil can be re-refined and brought to proper level by appropriate re-refining and reclanation techniques. For further details on refining, consult PCRA booklet titles how to Conserve Lubes' (through recycling). For any further information on this please contact PCRA, New Delhi.